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# Physics Flash

September 2019
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INSIDE



**Shea Mosby uses the Detector for Advanced Neutron Capture Experiments to study neutron absorption reactions on small quantities of radioactive or rare stable nuclei.**

## *Shea Mosby receives Presidential Early Career Award*

Shea Mosby (LANSCE Weapons Physics, P-27) has received a Presidential Early Career Award for Scientists and Engineers. The award is the highest honor bestowed by the US government on outstanding scientists and engineers in the early stages of their independent research careers.

"Shea is a deep-thinking early career scientist who has contributed to many of the nuclear reaction measurements done at the Los Alamos Neutron Science Center. He is currently developing a novel concept to measure nuclear reactions in radioactive isotopes," said Physics Division Leader David Meyerhofer.

Mosby earned his PhD in experimental nuclear physics from Michigan State University in 2011, where he studied nuclear structure. He came to Los Alamos as a postdoctoral researcher in 2012 to study neutron capture reactions for nuclear technology applications. He became a technical staff member in 2014 and now leads projects studying the nuclear fission process. Mosby's research at Los Alamos has focused on nuclear reactions relevant for applications using a variety of detector systems at the Los Alamos Neutron Science Center. He started at the Laboratory studying neutron capture using the Detector for Advanced Neutron Capture Experiments. Mosby recently began investigating novel approaches to measuring neutron-induced reactions for radioactive isotopes, which preclude traditional measurement techniques.

Established in 1996, the Presidential Early Career Award for Scientists and Engineers acknowledges the contributions scientists and engineers have made to the advancement of science, technology, education, and mathematics education and to community service as demonstrated through scientific leadership, public education, and community outreach. The White House Office of Science and Technology Policy coordinates the award with participating departments and agencies.

Materials and Physical Data's Abigail Hunter (XCP-5) also received a Presidential early career award.

*Technical contact: Shea Mosby*

"Physics Division is making a concerted strategic effort to align its weapons physics work to better match the changing and growing needs of the Laboratory's mission."

David

# From David's desk . . .

As I mentioned in my All-Hands Meeting earlier this month, members of the Applied Modern Physics group (P-21) will be moving to different organizations. The Prompt Diagnostics and Radiographic Science and Analysis teams will become part of the Neutron Science and Technology group (P-23) and the Magnetic Sensing and Miniaturization (MS&M), Quantum Communications, and Quantum Technologies teams will be joined by the current members of the Condensed Matter and Magnet Science group (MPA-CMMS) to form a new MPA group: Quantum Science and Systems (MPA-QSS).

Physics Division is making a concerted strategic effort to align its weapons physics work to better match the changing and growing needs of the Laboratory's mission. Underground test and radiographic analysis, two of these areas, are the focus of the Prompt Diagnostics and the Radiographic Science and Analysis teams. Moving these two teams into P-23 will allow enhanced synergies among the weapons efforts across the Division. The Division will be able to better exploit new opportunities in the subcritical experiment program (including Neutron Diagnosed Subcritical Experiments and Enhanced Capabilities for Subcritical Experiments), advance new initiatives in proton radiography and neutron imaging (including Inertial Confinement Fusion), better respond to an increasing need for underground test analysis and experimental uncertainty quantification, and optimally position the Division to best serve the changing mission landscape. Management will continue to look for additional synergies across the Division.

Quantum information science (QIS) has become a national priority, important for national security as well as national competitiveness. This priority, embodied in the National Quantum Initiative (NQI), is the motivation behind the Laboratory's Agenda goal: Assert leadership in NQI. The merging of the MS&M, Quantum Technologies, and Quantum Communications teams with personnel in MPA-CMMS whose scientific focus is quantum materials will provide LANL with an internationally recognized group that can solve impactful interdisciplinary problems in quantum science and systems.

It has been noted by internal and external advisory groups that, while LANL has multiple outstanding individual efforts in QIS, we are missing out on opportunities because these efforts are not interacting with one another. Integration of these efforts through the formation of this group will strengthen our overall QIS portfolio and increase our ability to attract external funding in this highly competitive field.

The placement of this quantum-focused group in MPA Division, rather than P Division, is due to the strong connections and collaborations between the current MPA-CMMS group and the Center for Integrated Nanotechnologies (MPA-CINT) and the National High Magnetic Field Laboratory-Pulsed Field Facility (MPA-MAGLAB). Following this reorganization, we hope to further strengthen the ties between the new group and the remaining groups in MPA and P divisions.

All current staff in P-21 and MPA-CMMS will be impacted by this reorganization, as their current groups will cease to exist on October 7. Larry Schultz will become the group leader of MPA-QSS and will remain in that role until his retirement early in 2020. Tom Venhaus will become a deputy group leader of MPA-QSS with another deputy designated from MPA-CMMS. Maria Rightley will become a deputy group leader in P-23.

The organizations to which all belong will change, but we don't anticipate other significant changes. While we hope and plan that these reorganizations result in new opportunities and areas to leverage one another, that will be an organic process rather a forced, team-shifting process or any other seismic shifts. Almost all staff will remain in their current offices and will be carrying out the same activities as they do today.

I thank the members of the MS&M, Quantum Communications, and Quantum Technologies teams for their service to the Division. It has been a pleasure working with them and I will miss them, but I will remain aware of what they are doing.

*P Division Leader David Meyerhofer*

## Physics Division staff in the news

### *Boshier recognized for outstanding mentoring*

Malcolm Boshier (Applied Modern Physics, P-21) received a 2019 Los Alamos Distinguished Mentor Award. The award, presented by the Student Programs Advisory Committee, recognizes outstanding performance by Lab mentors.

Boshier was nominated by Sara Hurd (P-21), a sophomore pursuing a degree in chemical engineering at New Mexico State University and a member of Boshier's Quantum Technologies team. Hurd noted Boshier's dedication to her education and growth as a scientist. Boshier encourages Hurd to be part of a high-level team by encouraging her to present her work alongside experienced team members and assigning her projects that capitalize on her strengths, challenge her limits, and contribute to the group's goals.

Boshier, who has a DPhil in physics from Oxford University, and his team of staff scientists, postdocs, and students develop applied quantum technologies. This work benefits the Laboratory's Global Security mission, its Science of Signatures science pillar, and the Laboratory Agenda strategic initiative to assert leadership in the National Quantum Initiative.

*Technical contact: Malcolm Boshier*

### *Roper, Sidebottom, Tafoya win best poster awards*

Three Physics students swept the physics category at the 2019 Student Symposium. Christopher Roper (Plasma Physics, P-24), Landon Tafoya (Neutron Science and Technology, P-23) and Rachel Sidebottom (Non-Destructive Testing and Evaluation, E-6) were recognized for their outstanding poster presentations.

Hosted by the National Security Education Center's Student Programs Office, the symposium provides students an opportunity to present their research and to network and make professional contacts.

Roper is pursuing his PhD in aerospace engineering at the Georgia Institute of Technology. This summer he worked with his mentor Samuel Langendorf (P-24) and members of the

**From left: Brittany Broder, Ethan Aulwes, Kristina Montoya, Colin Maez, Rachel Sidebottom, Emily Mendoza, Onnolee Englert-Erickson, Landon Tafoya, and Abel Raymer.**

Low Density Plasma Physics team to design an experiment to study velocity degradation mechanisms in linear plasma accelerators.

Tafoya is studying pre-engineering toward a bachelor's degree from Washington University in St. Louis. With mentors Verena Geppert-Kleinrath and Petr Volegov (both P-23), he analyzed measurements to determine the spot size of neutrons produced with a dense plasma focused source. The data will be used in the upcoming Neutron Diagnosed Subcritical Experiment, which supports LANL's stockpile stewardship mission.

Sidebottom, who was co-mentored by Michelle Espy (E-6) and Matt Freeman (P-23), is pursuing her bachelor's degree in biomedical engineering at Occidental College. She used proton and x-ray imaging to characterize test objects that mimicked tumors to explore the potential benefits of using protons for advanced cancer therapy.

## New boson may mediate exotic particle coupling

Scientists from Applied Modern Physics (P-21) have established the most precise experimental limit on fermion coupling, narrowing the theoretical bounds in which two particles can influence each other through exotic coupling—that is, effects resulting from particles not in direct contact with each other.

Scientists believe exotic coupling is mediated by a yet-unseen particle, the most plausible candidates being two types of bosons: the axion and the hidden photon. Finding either boson could explain some of the enigmas in physics beyond the Standard Model, including dark matter, dark energy, and the strong charge-parity problem. Because this exotic coupling violates parity symmetry, this work also has potential to provide a new source of symmetry violation.

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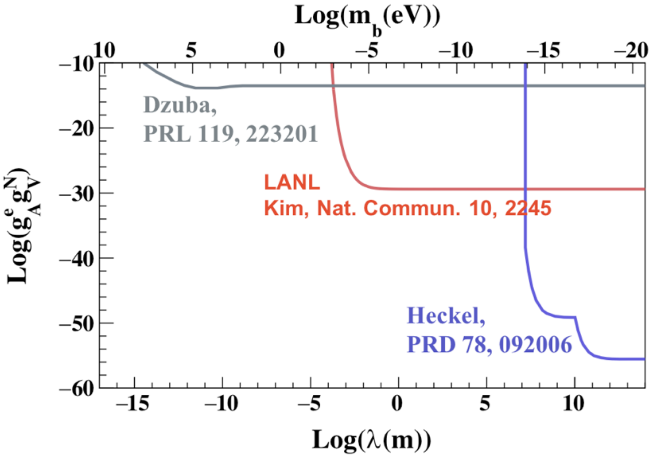
*New boson cont.*




**Experimental constraint of the LANL experiment on the electron-nucleon coupling as a function of the interaction range in the bottom axis and the boson mass in the top axis. The LANL experiment significantly enhances the current constraint by 17 orders of magnitude.**

In research appearing in *Nature Communications*, P-21 scientists defined the most precise limit on exotic spin- and velocity-dependent coupling between electrons and nucleons (protons or neutrons) and a limit on a new boson's ability to mediate such exotic coupling between ordinary particles. Their results reduce the current electron-nucleon coupling limit by up to 17 orders of magnitude.

This work relied on the group's previously developed, non-cryogenic, spin-exchange relaxation-free (SERF) atomic magnetometer that is highly sensitive—approaching femto-tesla sensitivity. This device served as both a source of polarized electrons and a magnetic-field sensor. In the experiment, the device recorded the induced magnetic field as a solid-state mass of unpolarized nucleons slowly oscillated nearby. The magnetic field changed as a function of distance between the electron and neutron sources, and the team applied Monte Carlo methods to calculate the coupling potential between the distant particles.

This work was funded by Los Alamos's Laboratory Directed Research and Development Program (LDRD Exploratory Research grant 20180129ER).

The work supports the Laboratory's Fundamental Science mission and Nuclear and Particle Futures science pillar by contributing to the grand scientific challenge of discovering physics beyond the Standard Model and its National Security mission by developing the pipeline of talent and technology required to solve national security problems.

Researchers: Young Jin Kim, Ping-Han Chu, Igor Savukov, Shaun Newman (P-21). Reference: "Experimental limit on an exotic parity-odd spin- and velocity-dependent interaction using an optically polarized vapor," *Nature Communications* 10, 2245 (2019).

*Technical contact: Young Jin Kim*

## 'Deconstructed' capsules reveal new details essential for achieving inertial confinement fusion

In research selected as an Editor's pick for *Physics of Plasmas*, Laboratory scientists and collaborators presented recent experimental results on energy transfer in double-shell implosions. Their work aids efforts to achieve nuclear fusion in a Laboratory setting.

For several decades, scientists have pursued designs to compress a sphere of deuterium and tritium using lasers to create fusion energy on demand, a process known as inertial confinement fusion (ICF). Double-shell capsules hold promise due to their design; however, the complexity of the system makes them difficult to build, diagnose, and simulate.

Using a series of "deconstructed" capsules, Los Alamos researchers and their external collaborators have developed a new diagnostic technique to successfully measure the energy transfer between the capsule parts, using the data to validate simulation codes used for ICF experimental design.

The work was enabled by the development of the imaging shell capsule, which includes a medium-density inner shell—instead of the standard high-density inner shell—that can be used to image the inner shell implosion with current imaging capabilities at the National Ignition Facility. This new imaging capability allows researchers to measure energy transfer in future double-shell capsule designs.

Their work is the first to successfully measure the inner shell kinetic energy, which is essential to driving the deuterium and tritium compression required for fusion. The experimental energy coupling to the inner shell matched within a few percent of simulation prediction, giving confidence in the design tools used for double-shell design.

The researchers also identified a key difference between the experimental results and the simulation data and in future work plan to investigate whether drive asymmetry or surface roughness instabilities may account for this difference.

This work leveraged Los Alamos high performance computing and target fabrication capabilities, as well as a fabrication collaboration between LANL, General Atomics, and Lawrence Livermore National Laboratory. The experiments were performed on the National Ignition Facility.

The Inertial Confinement Fusion and High Yield Campaign (LANL Program Manager: John Kline) funded the work, which supports the Laboratory's Energy Security mission and its Nuclear and Particle Futures and Information, Science, and Technology science pillars.

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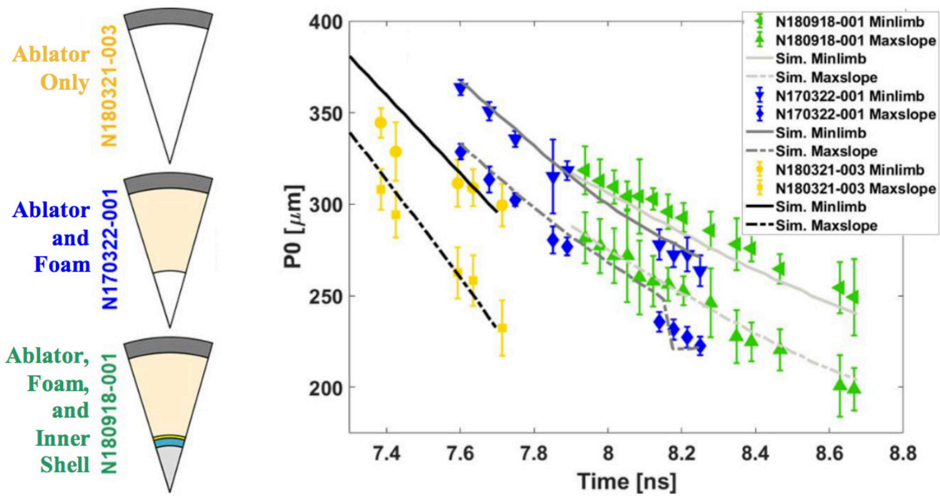
*'Deconstructed' capsules cont.*




**Three pairs of lines show simulated and experimental trajectories of the capsule ablator, in the form of the time-dependent capsule radius, P0, in µm. Using "deconstructed" capsules (illustrated at far left), the team measured the energy transferred through several layers within the capsule. Compared with the linear fit of the data, the simulated slope of the ablator-only capsule (yellow experimental, black simulation) shows slight differences; however, the capsule with an ablator and foam layer (blue experimental, grey simulation) and the capsule with ablator, foam, and inner shell (green experimental, light grey simulation) all showed strong agreement, giving confidence that the simulations match reality.**

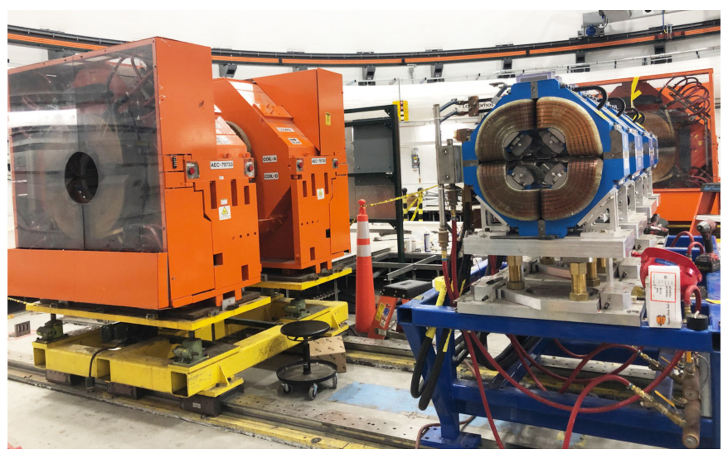
Researchers: E. Merritt (Plasma Physics, P-24); J. Sauppe (Plasma Theory and Applications, XCP-6); E. Loomis (P-24); T. Cardenas (Engineered Materials, MST-7); D. Montgomery (P-24); W. Daughton (Primary Physics, XTD-PRI); D. Wilson (XCP-6); J. Kline (Associate Laboratory Director for Weapons Physics, ALDX); S. Khan (Lawrence Livermore National Laboratory, LLNL); M. Schoff and M. Hoppe (General Atomics); F. Fierro, R. Randolph, B. Patterson, and L. Kuettner (MST-7); R. Sacks and E. Dodd (XCP-6); W. Wan, S. Palaniyappan, S. Batha, and P. Keiter (P-24); and J. Rygg, V. Smalyuk, Y. Ping, and P. Amendt (LLNL).

Reference: "Experimental study of energy transfer in double shell implosions." *Physics of Plasma* 26, 052702 (2019).

*Technical contact: Elizabeth Merritt*

## Proton Radiography Facility improvements boost safety, maximize experiment time

Recent improvements at the Proton Radiography Facility have streamlined the process for switching magnification systems, reducing the time required for system changes from days to hours. New rail tracks and improved power cables allow for safe and efficient experiment setup, making the most of available beam time during the Los Alamos Neutron Science Center's (LANSCE) run cycle.



**The Proton Radiography Facility's two quadrupole magnets, the Identity Lens (left) and the x3 Magnifier (right) are now mounted on rails for simplified experimental setup.**

Proton radiography (pRad) uses the LANSCE proton beam coupled with magnetic lenses to image materials under extreme conditions, revealing details that would be difficult to discern using traditional x-ray imaging techniques. Previously, changing the magnet configuration required a forklift, necessitating additional safety checks and caution to avoid jostling and potentially damaging the magnets. Connecting power to the magnets required specially-trained operators from Accelerator Operations (AOT-OPS).

New rail tracks, installed by members of Subatomic Physics (P-25), allow the magnets to be safely, gently, and quickly rolled into position. A new quick-disconnect power cable system, proposed by Jason Medina (P-25), eliminates the previously intricate process and features several integrated safety mechanisms, allowing safe and efficient power connection.

These experimental facility improvements, an example of excellence in mission operations supporting excellence in mission-focused science, technology, and engineering, were funded by the pRad Capability LANSCE High-resolution Spectrometer Deactivating and Decommissioning Project. The Lab's Weapons Program made this capability investment in support of national and international weapons science and stockpile stewardship programs. The improvements are part of an ongoing effort to restart dynamic experiments using plutonium. As a complement to the large-scale experiments at Nevada National Security Site, Pu@pRad will provide tomographic imaging and small-scale dynamic response studies on plutonium systems—and resolve features as small as a human hair.

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*Proton Radiography cont.*

**Previously power cables were bolted to the magnet (above), but with the new quick-disconnect system installed (right), workers such as Jason Medina (P-25) can connect power to the magnets safely and without delay.**

The work benefits research supporting the Laboratory's Nuclear Deterrence and Stockpile Stewardship mission areas and its Materials for the Future and Nuclear and Particle Futures science pillars by enabling studies on a wide range of materials under extreme pressures, strains, and strain rates. As a user facility, the Proton Radiography Facility is used by Los Alamos, other national laboratories, and academic institutions for unclassified and classified experiments.

Upgrade team members include Jason Medina, Julian Lopez, Levi Neukirch, Amy Tainter, Steve Greene, Fesseha Mariam, William Meijer, Andy Saunders, Tamsen Schurman, Zhaowen Tang, Dale Tupa, David Archuleta, Nicholas Lovato, Rayann Mora, Emily Rivera, Anthony Sanchez, Alexis Trujillo (all P-25).

*Technical contact: Kathy Prestridge*

## *Celebrating service*

Congratulations to the following Physics Division employees celebrating recent service anniversaries:

Raymond Gonzales, P-24 ........................................ 35 years
Frans Trouw, P-23 ........................................ 20 years
Matthew Devlin, P-27 ........................................ 20 years
Ming Liu, P-25 ........................................ 20 years
Shaun Newman, P-21 ........................................ 20 years
Larry Rodriguez, P-23 ........................................ 20 years
Ruben Manzanares, P-23 ........................................ 15 years
Karen Esquibel, P-21 ........................................ 10 years
Christine War, P-23 ........................................ 10 years
Hye Young Lee, P-27 ........................................ 10 years
Alicia Lujan, P-27 ........................................ 5 years
Zhaowen Tang, P-25 ........................................ 5 years

# HeadsUP!

## 'Heads Up, Devices Down' team wins Jane Hall Award

The second annual Jane Hall Award was presented to the TA-53 Worker Environmental Safety and Security Team (WESST) for its "Heads Up, Devices Down" safety awareness campaign. Approximately 40 "Heads Up, Devices Down" reminders are painted at LANSCE and the campaign has taken off Lab-wide.

With thousands of reports of accidents—including fatal ones—in the United States involving people distracted by their mobile devices, the TA-53 WESST started the "Heads Up, Devices Down" campaign at the Los Alamos Neutron Science Center (LANSCE) to alleviate potential incidents in that area.

Team members: Melvin Borrego (LANSCE Weapons Physics, P-27); Mary Hockaday (Nuclear Engineering & Nonproliferation, NEN-DO); David Meyerhofer and Eric Pitcher (Physics, P-DO); Leo Bitteker and Tracy Salazar (LANSCE Facility Operations, LANSCE-FO); Ray Richey (Logistics Superintendent Field Work Execution, LOG-SUP); Josh Ebersole, Eric Martinez, Ian Ball, Sam Maestas, Sean Patrick, Arsenio Martinez, and Michael Rodriguez (Logistics Central Shops, LOG-CS).

**PhysicsFlash**

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For past issues, see www.lanl.gov/orgs/p/flash_files/flash.shtml.

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